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Energy Efficient Features of Vernacular Houses in India: A Review

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Abstract—*Vernacular houses are climate responsive and are known to have maintained comfortable indoor thermal environment. Vernacular architecture differs geographically as per the varied climate, topography of the area along with availability of building materials. This has resulted in evolution of varied type of vernacular architecture that explains the difference of building consecution techniques of hills from that of plain areas. Most importantly the features of vernacular houses are affected by the climatic factors. Present paper addresses different research works regarding the thermal performance of vernacular houses located in different climatic regions of India. This paper also describes merits of the vernacular houses which can be successfully clubbed up in modern houses with respect to different climatic regions.*

1. INTRODUCTION

India is a vast country with diverse cultural heritage and religious beliefs, climatic diversity and buildings providing shelter to people. India has been divided into five climatic zones: hot-dry, warm-humid, composite, temperate and cold [1, 2, 3]. Each climatic zone has different characteristics corresponding to topography, geography, temperature, rainfall, humidity and other climatic factors in addition to socioeconomic and cultural backgrounds [4]. Naturally ventilated and vernacular buildings have always performed better in the maintenance of indoor thermal comfort environments as shown by research studies [5], [6].

2. THERMAL STUDIES FOR ACHIEVING ENERGY EFFICIENCY IN VERNACULAR HOUSES IN INDIA

Few thermal comfort studies regarding the vernacular building of composite climate have been reported from India in recent years. Recent thermal comfort research studies in India mainly focused on: i) passive control techniques of traditional buildings of Kerala helping in maintenance of indoor thermal comfort environment located in warm-humid climate by Dilli et.al. [6], ii) hot-dry climate for residential apartment buildings in Hyderabad by Indraganti and Rao [7], iii) thermal comfort in railway terminal of Chennai set in hot-humid climate by Deb and Ramachandraiah [8], iv) thermal performance of naturally ventilated buildings located in hot-dry and warm-humid climate [9], v) solar passive techniques in vernacular buildings effectively maintaining comfortable indoor environment of coastal regions of Tamil-Naidu set in warm-humid climate by Priya et.al. [10], vi) thermal environmental conditions of naturally ventilated hostels of undergraduate students of Jaipur set in composite climate by Dhaka et.al. [11], vii) naturally ventilated vernacular buildings of Bangalore set in warm-humid climate by Praseeda et.al. [12], viii) thermal study of undergraduate laboratories in Kharagpur located in tropical climate by Mishra and Ramgopal [13], ix) thermal comfort performance of naturally ventilated building of Jaipur located in composite climate by Dhaka et.al. [14], x) vernacular buildings of north-eastern India located in warm-humid, cool-humid and cold & cloudy climate [15].

Indraganti [16] has shown that a general thermal comfort model cannot be developed for all the climatic zones. Due to the difference in climatic conditions and most importantly in socioeconomic and cultural parameters of the area, different thermal comfort models are required to define comfortable temperatures of the area specific. These comfort models should be developed on the basis of indoor and outdoor temperature, relative humidity, and clothing pattern of people of the particular region.

Dilli et al. [6] used adaptive approach for evaluation of thermal comfort in vernacular houses comparative with modern houses in a warm-humid climate of Kerala. The study found that in case of traditional houses; passive bioclimatic features like proper arrangement of building blocks around central open courtyards set according to geometrical principles, provision of 10° roof slope towards north and south side for easy drainage of rainwater, more height of rooms than modern houses, shading of windows as protection against excessive sun, wind and rain, all effectively lowered indoor room temperature by 3°- 8°C comparative with outdoor temperature and increased indoor humidity levels to 50%-80% as against 32%-95% outdoor humidity levels which resulted in comfortable indoor environment. Further the maximum indoor temperature of rooms of modern houses was found to be higher comparative with traditional houses by 2.5°C. The results proved that natural ventilation and building

envelope are very important parameters that regulate air temperature, relative humidity and air speed, controlling solar radiations, providing comfortable indoor environment without input of extra external energy equipment.

Singh et al. [15], Indraganti [16] determined the comfort temperatures from mean monthly temperatures. In the development of thermal comfort model for North-east India, Singh et al. [15] studied design parameters like external wall thickness, construction material, inter-room partition wall thickness, false ceiling height, doors and windows dimensions influencing indoor thermal comfort. In the same study, these parameters were compared for different climatic zones of the region. Singh et al. studied thermo-physical features of a building along with socio- economic and cultural features which govern the thermal comfort pattern in the region [89]. This further elaborates the adaptations involved by people in the built masses for their comfort. Review of thermal comfort study in India indicated gaps in the research field regarding comparative thermal comfort study of both vernacular houses and Conventional modern houses as indicated in Table 1 that clearly shows the research gaps in thermal comfort studies for vernacular houses in India.

Table 1: Thermal comfort study in India and research gaps identified

Climate/ Area	Research Work	Context	Limitation:
Composite, Jaipur	Naturally ventilated building, hostels	Modern buildings	Study addresses only modern buildings ignoring vernacular buildings
Hot-dry, Hyderabad	Residential apartment buildings and Office buildings	Modern buildings	
Tropical (Kharagpur)	Undergraduate laboratories	Modern buildings	
Tropical (Kharagpur)	Undergraduate laboratories	Modern buildings	
Tropical (Kharagpur)	Undergraduate laboratories	Modern buildings	
North East: Warm-humid (Tezpur) Cool-humid (Imphal) Cold–cloudy (Cherrapunjee)	Residential buildings	Vernacular buildings	Study addresses only Vernacular buildings ignoring modern buildings
Warm-humid (Bangalore)	Naturally ventilated buildings	Vernacular buildings	
Warm-humid (Kerala)	Individual House	Traditional buildings	
Warm-humid (Tamil Naidu)	Individual House	Vernacular buildings	

3. CONCLUSION

Review of various thermal comfort studies in India clearly shows that design and planning parameters like thickness of walls, orientation of house with respect to sun and wind direction, spatial arrangement of rooms opening size and location , use of building construction materials, provision of open spaces like courtyard or solariums, all are significant energy efficient techniques which not only have a significant role to play in maintaining comfortable indoor environment but also in saving energy which definitely has a very promising future ahead in housing and building industry.

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